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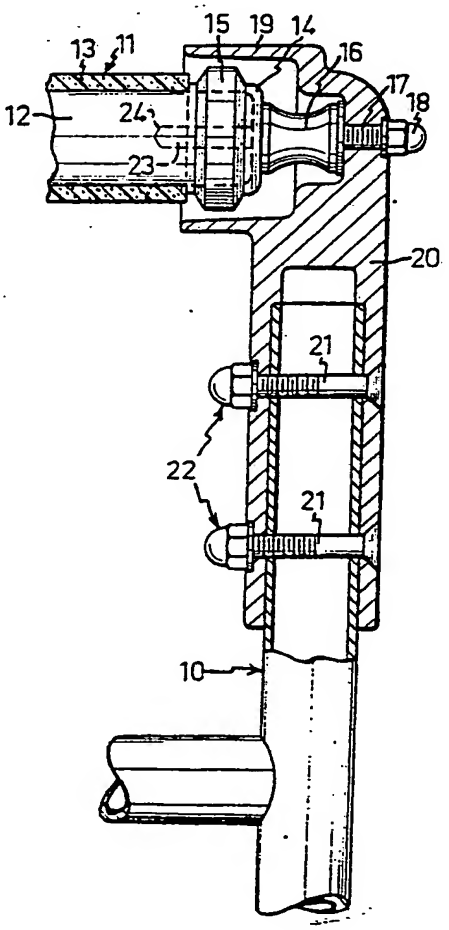
(54) Title: VIBRATING PLATE

(57) Abstract

A vibrating plate has a compactor plate with engine and vibration generator and a handle for the operation of the vibrating plate. The shaft and operating members (10 and 11, respectively) of the handle are interconnected by means of spring elements (16) and a spring deflection restricting device (14, 19). According to the invention, the mass of the operating member (11) and the spring stiffness of the spring element (16) are so adapted to one another and to the vibration frequency of the vibrating plate that the relationship of said frequency and the characteristic frequency of the operation member with regard to translational and rotational movements respectively along and about the axis of the operating member and respectively along and about two directions at right angles to the axis and also to one another, is > $\sqrt{2}$.



# VIBRATING PLATE

This invention relates to a so-called vibrating plate, that is a device which comprises a compactor plate with engine and vibration generator, said compactor plate being adapted for application to the ground. Such vibrating plates can be used for compaction of sand and gravel as well as asphalt coatings. Such vibrating plates have a handle by which the vibrating plate is operated. A difficult problem associated with this type of tool resides in the transmission of vibrations from the vibrating plate to the operator. Therefore, one has tried in different ways to dampen the transmission of vibrations. Such a prior art device for damping the transmission of vibrations is described in EP-A-0,081,079 and the corresponding published Swedish patent applications SE-A-8107365-2 and 8203697-1. This publication describes a handle arrangement in which biased elastomer springs are utilized between the operating member and the shaft member.

Another prior art device for damping vibrations between a vibrating tool and a handle is described and shown in US-A-4,282,938, where the damping of the vibrations is absorbed with the aid of leaf spring elements and a magnetic damper.

The first of these prior art devices have proved to be unsatisfactory for damping vibrations from a vibrating plate even though this device is useful for light-weight equipment. The last-mentioned prior art device is disadvantageous in that it is expensive and requires much material.

This invention aims at providing a vibrating plate in which the operating and shaft members of the handle are interconnected by at least one spring element the stiffness of which has been adapted to the mass of the operating member such that an excellent vibration insu-

In a further development of the invention the spring deflection restricting mechanical device is formed by a cup-shaped means which is connected to the shaft member of the handle and has a larger inner diameter than the outer diameter of the part of the operating member projecting into said cup-shaped means. It is particularly advantageous if the part projecting into the cup-shaped means is provided with a preferably annular, shock-absorbing and shock-damping elastomer element adapted to engage said cup-shaped means.

To further insulate the operator from the vibrations of the vibrating plate the operating member preferably has a jacket of resilient elastomer material.

The invention will now be described more in detail with reference to the accompanying drawings in which:

Fig. 1 shows an example of a handle for a vibrating plate according to the present invention;

Fig. 2 shows a basic sketch for calculation of spring stiffness and mass of the handle device for the vibrating plate;

Fig. 3 shows parts of another example of a handle for the vibrating plate according to the present invention;

Fig. 4 shows a further example of a vibrating plate with a separately mounted operating member; and

Fig. 5 shows a diagrammatic side view of a vibrating plate according to the present invention.

The vibrating plate according to the present invention is diagrammatically shown in Fig. 5 and comprises a compactor plate 50 which is adapted for application to the ground and which supports an engine 51 with a vibrating device (not shown in detail). Besides the vibrating plate has a handle 52 which comprises a shaft member 53 and an operating member 54.

Fig. 1 shows an example how the handle for the vibrating plate according to the invention may be de-

integral with the cup-shaped means 19 into which the operating member 11 of the handle projects. This embodiment of the handle and its operating member 11 differs from the embodiment shown in Fig. 1 also with regard to the connection of the elastomer spring 16 with the operating member 11 and the angle piece 20. In this instance, too, the elastomer spring 16 is in the shape of an hour-glass or dumbbell and has metal plates vulcanized to its end surfaces. The right-hand metal plate shown in the drawing is connected to the fastening bolt 17 which penetrates through a hole of the angle piece 20 and is clamped thereto by means of the nut 18. The metal plate vulcanized to the other end of the elastomer spring 16 is integral or united with a cylindrical pin 23 which projects into a cylindrical bore 24 in the end surface of the core 12 of the operating member. The core 12 with its jacket 13 is thus rotatable in relation to the elastomer spring 16. The embodiment according to Fig. 3 differs from that of Fig. 1 also with regard to the cup-shaped means 14 which in this case is facing in the opposite direction and thus grasps the core 12 and is connected thereto. Same as earlier, an annular rubber body 15 is fastened to the outer side of the cup-shaped means 14 in order to serve as a spring deflection restricting device together with the cup-shaped means 19 on the angle piece 20.

In Fig. 4 there is shown a further example how the vibrating plate according to the invention may be provided with a handle for vibration insulation. In Fig. 4 use has been made of the same reference numerals as earlier for the various components. The difference in this case is that the handle is mounted with the aid of special brackets 30 which are mounted on the handle 10 of the vibrating plate by means of bolts 31 and a clasp 32. Another difference resides in that the cup-shaped means 14 in this case is vulcanized in one piece with the elastomer spring 16 and provided with the elastomer ring 15 on its outer side.

movements there is a characteristic frequency which is important in conjunction with the present invention. To obtain a fully satisfactory insulation of the operating member 11 relative to the shaft portions 10 it has been found, according to the invention, that these characteristic frequencies must lie considerably lower than the interfering frequency (the main frequency of the vibration generated by the vibrating plate), the best insulation being obtained if the relationship between the interfering frequency and the respective characteristic frequency is $> \sqrt{2}$.

As the suspension of the operating member is a so-called three-symmetry suspension the calculation of the characteristic frequncies can be simplified considerably. The characteristic frequencies are therefore calculated in the following manner:

Translational motion

Z-direction $$f_z = \frac{1}{2\pi}\sqrt{\frac{2\,k_z}{M}}$$

Y-direction $$f_y = \frac{1}{2\pi}\sqrt{\frac{2\,k_y}{M}}$$

x-direction $$f_x = \frac{1}{2\pi}\sqrt{\frac{2k_x}{M}}$$

$k_x$ is the stiffness of the spring element in the X-direction in N/m

$k_\beta$ is the torsion stiffness of the spring element about the Y-axis in Nm/radian

$a_y$ is the center-of-mass distance to the line of symmetry of the spring, meter measured along the Y-axis

$\rho_Z$ is the radius of gyration of the operating member with respect to the Z-symmetry axis, meter

$\rho_X$ is the radius of gyration of the operation member with respect to the X-symmetry axis, meter

If the spring constants of the two springs 16 are adapted in such a way that each of the characteristic frequencies indicated above is so much less than the vibrating plate interfering frequency caused by the vibration that the relationship between said frequency and the respective characteristic frequency of the operating portion is $> \sqrt{2}$, one will obtain a very good vibration insulation. By reason of the design of the spring elements in the shape of hour-glasses or dumbbells and by the absence of a bias of the spring elements, a very long life will be obtained for the spring elements and the fastening of the operating member in the shaft members. With the use of the vibrating plate the operating member will thus be very satisfactorily vibration insulated in relation to the rest of the vibrating plate, which makes it more convenient for the operator to handle the machine and will also reduce the risk of occupational injuries. When the machine is turned or otherwise handled and the operator exerts a considerable force on the member 11, the rubber ring 15 fastened to the cup-shaped means 14 will engage the inner side of the cup-shaped means 19 such that an exact operation of the machine is not prevented by the spring arrangement. This spring deflection restricting device also permits lifting of the vibrating plate by the handle without any risk that the spring elements 16 will be damaged.

prises a cup-shaped means (19) connected to the shaft member (10) of the handle and having a larger inner diameter than the outer diameter of the part (14) of the operating member (11) projecting into said cup-shaped means.

5. A vibrating plate as claimed in claim 4, c h a r a c t e r i s e d in that the part (14) of the operating member (11) projecting into the cup-shaped means (19) has a shock-absorbing and shock-damping elastomer element (15) which is adapted to engage said cup-shaped means (19).

6. A vibrating plate as claimed in any of claims 1-5, c h a r a c t e r i s e d in that the operating member (11) has a jacket (13) of resilient elastomer material.

Fig.3

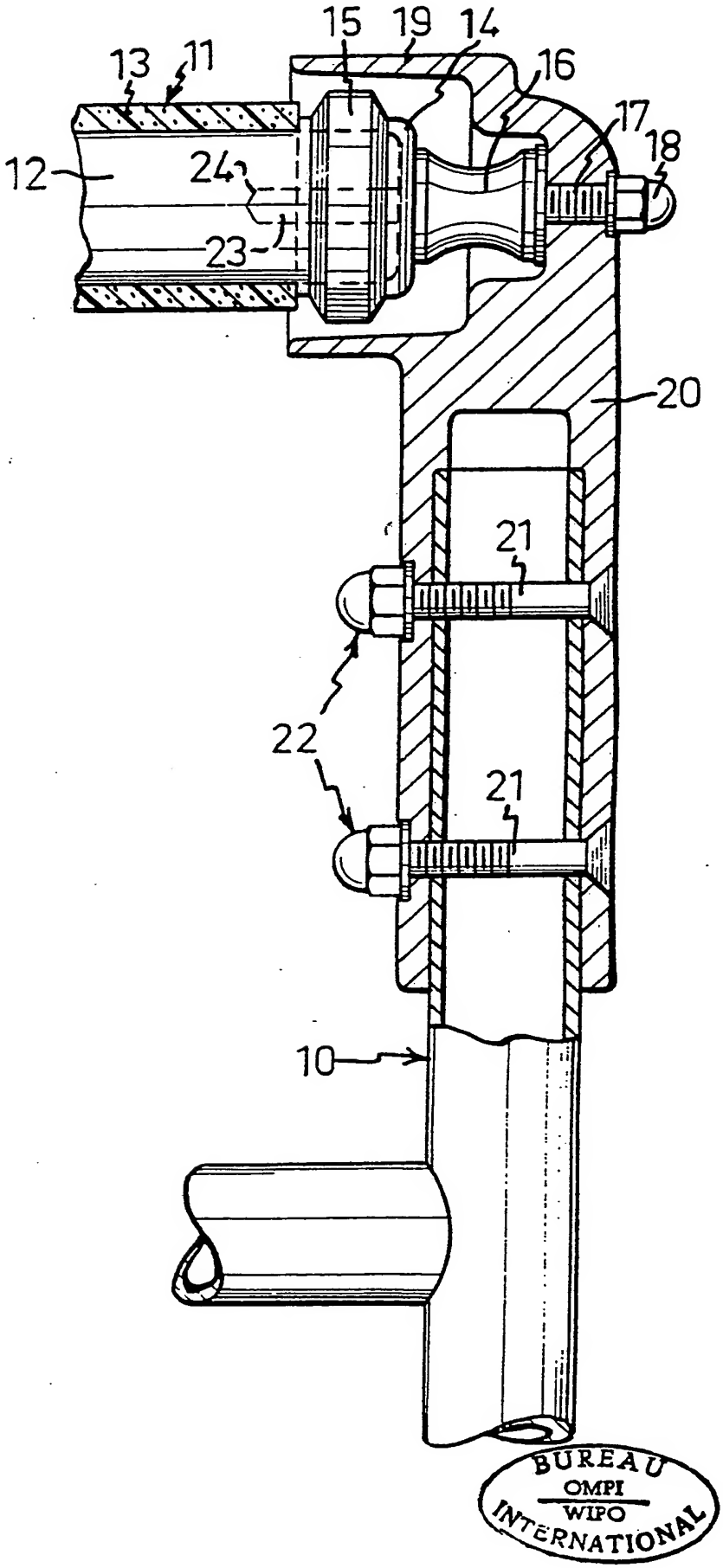



Fig.2

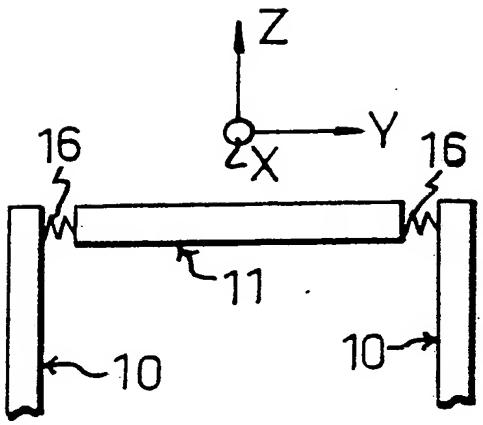
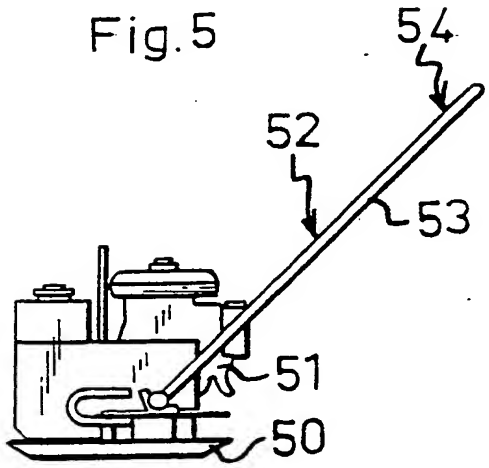



Fig.5



# INTERNATIONAL SEARCH REPORT

International Application No PCT/SE84/00205

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

F 16 F 15/08, E 02 D 3/046

## II. FIELDS SEARCHED

Minimum Documentation Searched [4]

| Classification System | Classification Symbols |
|---|---|
| IPC 3 | F 16 F 1/38, 3/08, 7/00, 10, 12, 15/04, 08;B 25 D 17/04, 24; B 25 G 1/00, 02, 10; E 02 D 3/00-074; E 01 C 19/22-29, 32-41 |

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [5]

SE, NO, DK, FI classes as above

## III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

| Category * | Citation of Document, [16] with indication, where appropriate, of the relevant passages [17] | Relevant to Claim No. [18] |
|---|---|---|
| Y | US, A, 3 232 188 (F.M. FROHNAUER) 1 February 1966 | 1 |
| Y | DE, A, 3 121 882 (HITACHI KOKI CO.LTD) 11 February 1982 | 1, 4, 5 |
| A | DE, C, 700 854 (ROBERT WACKER) 28 November 1940 | 1-3 |
| P | EP, A, 0 081 079 (SUNNE GUMMIFABRIK AB) 15 June 1983 | 1 |

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

## IV. CERTIFICATION

| Date of the Actual Completion of the International Search [2] | Date of Mailing of this International Search Report [2] |
|---|---|
| 1984-08-17 | 1984 -08- 22 |
| **International Searching Authority [1]** | **Signature of Authorized Officer [20]** |
| Swedish Patent Office | Hans Hagström |

L.E.

Form PCT/ISA/210 (second sheet) (October 1981)